REMARKS

Claims 1, 8, 18, 21, 25, 29 and 35 have been amended to delete reference to a center line in the invention definition represented by those claims. Reference to a center line in those claims is believed by applicants to be unnecessary in that the definition of a thread taper does not need reference to a center line. Taper is the difference in diameter between two axially separated cross sections of a conical surface.

Taper may be measured in inches per foot. Applicants have chosen to continue to include the reference to a common center line in Claim 30. Both thread taper and crest taper are referred to a centerline C/L in Claim 30. Amendments as described above are provided for clarity of the claims and of course are not made for patentability reasons.

Applicants do not understand the Examiner's reference to "common center-line (any convenient line)" at page 4, line 4 of the Office Action. Applicants' reference to common-center line refers to the axis C/L (Figure 2, for example) of the connected joint. It is the common axis of the pin and box once they are made up.

Applicants do not understand the examiner's statement (at page 4, line 11) that "Rollins teaches a center line being greater than a thread taper lower of 1.0 inch per foot, etc." Applicants specify a thread taper (T_{th}) which is greater than a thread taper of 1.0 inch per foot and which is less than an upper limit of 1.2 inch per foot.

Applicants respectfully request reconsideration of the rejection of Claims 1-3 as defining an obvious invention over Payne (6,244,631) in view of Rollins (2,885,225) in view of the analysis below.

Payne Disclosure

Payne does disclose a double shoulder connection for a drill pipe. Payne does not disclose or suggest the structure following the "characterized by" clause of Claim 1, namely,

> said internal threads (20) and said external threads (18) having a thread taper (T_{th}) which is greater than a thread taper ($T_{th\ lower}$) of 1.0 inch per foot, and which is less than an upper limit ($T_{th\ upper}$) of 1.2 inch per foot.

Payne incorporates by reference application no. 08/850,658 (col. 8, line 63) now U.S. 5,908,212. That '212 patent discloses a thread taper not greater than 1 inch per foot and preferably not greater than 0.8 inch per foot (see col. 5, lines 52-60) of the U.S. 5,908,212 patent. The '212 patent further indicates that standard connections provide a thread taper between 1.25 and 2 inches per foot.

Thus it is clear that Payne teaches away from the range for a thread taper defined by the characterizing clause of applicants' mention of Claim 1 which specifies a thread taper range between 1 and 1.2 inches per foot.

Rollins Disclosure

Rollins discloses a coupling having two box ends for connecting a drill pipe having pin threads at each end. Each pin - box thread arrangement provides shallow threads, but the connection does not have pin external and internal shoulders which engage respective box external and internal shoulders. Rollins provides an external peripheral seal between surfaces 22, 40 at the ends of the coupling and between interfering threads. Rollins does not disclose a double shoulder connection as defined by applicants' Claim 1. See especially Rollins at col. 2, lines 5-25. Rollins discloses a minimum taper of 1.0 inch per foot to limit tangential force (thus torque) during make up of the connection (see col. 2, lines 5-25) and to limit hoop stresses which could split the box. Rollins also specifies a maximum taper of 2.0 inches per foot and an optimum taper of 1.5 inch per foot.

Differences between a double shoulder connection (as in Payne) and pipe coupling connection (as in Rollins)

Double shouldering connections (as in Payne) are designed for the additional torsional resistance that the internal shoulder provides. In other words, the connections are designed for high torque application of drill strings for oil and gas wells. Here are a few design variables that can be manipulated.

- A shorter threaded length L_{TH} can be provided, but it must be long enough to provide enough shear strength to carry the axial loads from the shoulders.
- A smaller thread height can be provided, but the threads must be tall enough to prevent thread "jump out."
- A longer thread lead can be provided, but this tends to make the connection easier to come apart in reverse torque.
- The thread loading angle can be increased, but too large a loading angle tends to cause the box counterbore section to be more likely to crack.
- The taper as specified in U.S. Patent 5,908,212 (the "Payne" patent) can be reduced. A commercial product, the "XT" connection, is commercialized with a reduced taper. However, the taper is reduced to such a large degree that a large number of turns is required in the XT connection. This tends to increase the number of turns from stabbed to snugged. Furthermore, reducing the taper makes it more difficult to stab and more different to get the threads to start engagement. Carried to a limit, a small taper could be straight threads with zero taper. In that case, the threads cannot be stabbed at all and alignment to start the threads engaging must be almost perfect.

The Rollins patent disclosure is for a drill pipe connection of a past era (1959). There are many differences between modern day drill pipe connection as in Payne and the coupling arrangement of Rollins.

Rollins' patent describes a connection between a drill pipe joint and a pipe coupling (col. 1, lines 16-22). Drill pipe couplings used in the 1959 era to connect sections of steel drill pipe, have been replaced by the welded drill pipe, with a welded box portion on one end of a drill pipe section and a welded pin portion on the other end.

A connection with one or more shoulders, such as the connection of Payne and of applicants' invention, do not see the wedging action to the extent described in the Rollins patents. The shoulders of applicants' invention provide enough mechanical advantage to prevent the wedging mentioned in column 2, lines 7-11 of Rollins.

The issue of coming apart in reverse torque is mentioned in Column 2, lines 47-50 of the Rollins patent. Without a shoulder, the only resistance to coming apart in reverse torque is a small, but controlled amount of wedging. In a single shouldering or double shouldering connection, as in applicants' invention, this is achieved through friction due to pressure at the shoulder(s). In Rollins, pressure to come apart is reduced due to the double threads. Thus Rollins non-shouldering connection with double-threads resists revenue torque. But if Rollins were to have in addition a shouldered connection, there would be a higher risk of the connection coming apart due to the double threads. Indeed, Rollins discloses a double-thread and specifies a double thread in each of his four claim definitions.

Applicant provides a shouldered arrangement with a single thread unlike the Rollins arrangement.

The issue of make up speed is also addressed in Rollins. Rollins states (col. 2. lines 59-60): "a double thread will make up twice as fast as a single thread." Applicant's connection with a single thread and shouldering connection achieves rapid make up without double threads.

No Motivation to Combine Rollins Teaching with those of Payne

One of ordinary skill in the thread connection art would not be motivated to substitute the thread taper range of Rollins (between 1 and 2 inches per foot with an optimin taper of 1.5 inch per foot) for the taper range of Payne (less than 0.8 inch per foot).

The routineer seeking possibly to improve on Payne's connection (double shoulder connection), would not be motivated to apply a thread taper range from an entirely different Rollins connection arrangement, (peripheral external seal with sealing between threads). The routineer would have no teaching from Rollins that improvement is possible in Payne's connection arrangement by specifying a taper range between 1 and 1.2 inches per foot, because the forces acting on the two connections are so totally different due to the different structures.

Accordingly, applicants request, for the reasons outlined above, that the examiner reconsider the rejection of Claim 1 on obviousness grounds and allow Claim 1.

Claims 2, 3

Applicants respectfully disagree, with respect to Claim 2, that there is disclosure in Payne that thread characteristics of pitch, thread major diameter and thread pitch diameter are arranged and designed so that less than 8 turns are required from stabbed to snugged. Rollins does not provide disclosure for that characteristic either. Thus, Claim 2, dependent on Claim 1 and patentability distinct from Payne in view of Rollins as shown above, is also patentably distinct because of the limitation regarding the stabbed to snugged characteristics of the claimed arrangement.

Applicants' Claim 3, which specifies a connection as defined by Claims 1 and 2 further specifies a particular connection structure that is characterized by a thread taper of about 1.125 inches per foot and a stabbed to snugged turn characteristic of six. Neither Payne nor Rollins describe such a connection.

Claim 4

Claim 4 of this application specifies a connection of Claim 1 but with further limitations as to thread depth. Contrary to the examiner's comments as to Smith's disclosure, Applicants respectfully point out that Smith does not teach a thread depth of about one-half of the height of a fundamental triangle of the threads of a threaded tubular connection. Applicants' Claim 4 has been amended to delete the phrase "or less" from the original claim definition.

U.S. patent 5,908,212 (incorporated by reference by the Payne cited reference) does not disclose a specific value of the thread height parameter. An inspection of Figures 2-3 of that patent appears to be about 0.75.

Rollins recommends a unit thread height of 0.375 within a range of 0.25 and .50. See column 2 to column 3 under the heading Thread Height.

Smith (U.S. 6,447,025) does not disclose a specific value for the thread height parameter. Figures 2 and 3 appear to disclose thread heights of 0.7 and 0.6, but Smiths' patent drawings may not be drawn to scale.

Neither Payne (or U.S. 5,908,212), Rollins, or Smith disclose or suggest the characteristic of Claim 4 in combination with the structure of Claim 1. Accordingly, Claim 4 is patentably distinct over Payne in view of Rollins and Smith.

Claims 5 and 6

U.S. 5,908,212, referenced in Payne, appears to disclose a (standard) flank angle of 30°. That angle is identical for stab and load flanks: see Figs. 2.3

Rollins discloses a small flank angle (14½ degrees for the preferred unit thread height, 11° for a unit thread height of 0.5 and 21° for a unit thread height of 0.25: see column 3 line 70 - column 4 line 9) and does not mention any difference between flank and stab flank angle.

Smith (US '025) discloses flank angles of around 30° for both stab and load flanks (examples are given: 32° and 35° for stab flanks).

None of the above references alone or when combined together express or imply a non-symmetrical profile with a stab flank angle between 35 and 42° and a different load flank angle (between 25 and 34°) as specified in applicants Claim 5 and 6. Accordingly, Claims 5 and 6 define a patentably distinct invention over Payne in view of Rollins in view of Smith.

Claim 7

None of the cited or incorporated documents discloses or suggests a connection in which the thread roots are formed in a shape of a portion of an ellipse.

The Smith patent discloses a larger radius for the thread root (see column 4 lines 17-18) but not an elliptic shape. Accordingly, Claim 7 defines a patentably distinct invention over Payne in view of Rollins in view of Smith.

Claim 8

Neither Payne nor U.S. 5,908,212 say anything about the thread crest taper which appears to be identical to the thread taper (at the pitch line) from inspection of the issued patent drawings.

Rollins discloses (column 4 paragraph VI: thread crest taper) a thread crest (30, 41) taper identical to the land (22, 40) taper.

Smith also discloses thread crests (42) which are parallel to the pitch line (column 3, lines 50-53): thus, crest taper is identical to thread taper. Smith also provides for crest surfaces 42 to be inclined relative to the thread taper (column 3 lines 53-54) without further indication on the direction of the inclination, but we can interpret from the end of the sentence that the crest surfaces slope is in the same direction as the thread taper.

None of these documents discloses or suggests a crest taper sloping at an opposite direction from that of the thread taper. Accordingly, Claim 8 defines a patentably distinct invention over Payne in view of Rollins in view of Smith.

Claim 9

Payne and Rollins do not disclose anything about the radius of curvature between load flank and crest.

Smith discloses a prior art value of 0.015 inches radius (column 3, lines 59-60 and between 0.013 and 0.017 inch (col. 4, lines 55-66) for their connection.

None of these references disclose or suggest a radius value of 0.012 inch or less as specified in Claim 9. For that reason and further by the fact that Claim 9 depends from Claim 5, Claim 9 is patentably distinct over the references cited by the examiner.

Claim 10

Payne, U.S. '212, and Rollins do not say anything about the radius of curvature between stab flank and crest.

Smith discloses a small radius for the prior art (0.015 inch - see column 3, lines 59-60), which is much less than the crest width: and a rather large 0.065 inch radius (38) for the Smith connection (see column 4, lines 22-24). But Smith does not disclose a crest width value in order to calculate a ratio between the radius 38 and thread width 42 and to compare it with the minimum value of 80% as specified in Claim 10. Accordingly, neither Smith nor U.S. '212 nor Rollins nor Payne disclose or suggest the structure of Claim 10. Furthermore, Claim 10, dependent on Claim 5, is patentably distinct over the cited references.

Claims 11, 12

Each of these claims depends on Claim 7 and 1 respectively and are patentably distinct, because they depend from a patentable claim.

Claim 13

U.S. '212 discloses a value for the length 45 of the counterbore section (at least 1.5 inches, preferably at least 2 inches: column 6, lines 10-13) but not for that of the pin nose. From Fig. 2-3, it appears the length of the pin nose section is less than length 45 of the counterbore section.

Rollins is not relevant (no forced shoulders, no pin nose, tapered counterbore).

Smith does not disclose a double shoulder connection and there is no pin nose (see Fig. 1).

Accordingly, Claim 13 with $L_{PN} \geq L_{BC}$ patentably defines over the cited references. Furthermore, Claim 13 depends from Claim 1 which as shown above is patentably distinct over the prior art. Likewise, Claim 13 by its dependence from Claim 13 is patenable.

Claim 14

U.S. '212 discloses a value for the length 45 of the counterbore section which is at least 1.5 inches, but Claim 14 recites a length around 1 inch. Claim 14 depending from Claim 13 is patentably distinct over the references by its dependence on Claim 13 and further because of the recited lengths being new and unovbious over the cited prior art.

Claims 15, 16, 17, 18, 19, 20

Each of these claims depend from Claim 1 and specify further structural cooperation among parameters which characterize the claimed connections. None of these parameters are disclosed in Payne or Rollins or Smith in the arrangements specified by these claims. Accordingly, each of these claims patentably define over the cited references.

Claim 21

This independent claim has a limitation regarding stab flank angle and load flank angle like that of Claim 5 substituted for the thread taper limitation of Claim 1. Kindly see the remarks above with respect to Claim 5 as to why the cited references do not disclose or suggest the threaded connection defined by this claim. Accordingly, Claim 21 defines patentably over the cited reference.

Claims 22 and 23

These claims are dependent from Claim 21 and for that reason define over the references. Such claims are further patentably distinct over the cited patents for the same reasons advanced above for Claims 4 and 6.

Claim 24

Claim 24, dependent from Claim 21, is further patentably distinct over the cited references for the same reasons advanced for Claim 7 above.

Claim 25

Claim 25, dependent from Claim 21, is further patentably distinct over the cited references for the same reasons advanced for Claim 8 above.

Claim 26

Claim 26, dependent from Claim 21, is further patentably distinct over the cited references for the same reasons advanced for Claim 9 above.

Claim 27

Claim 27, dependent from Claim 21, is further patentably distinct over the cited references for the same reasons advanced for Claim 10 above.

Claim 28

Claim 28, dependent from Claim 21, is further patentably distinct over the cited references for the same reasons advanced for Claim 11 above.

Claim 29

Claim 29, dependent from Claim 22 is further patentably distinct over the cited references advanced for Claim 3 above.

Claim 30

This independent claim has a "characterizing" limitation regarding the internal and external threads having a crest taper which slopes in a different direction from that of the thread taper. Such limitation defines a connection which is patentably distinct over the cited references for the same reasons advanced above with respect to Claim 8.

Claims 31, 32, 33.

These claims, dependent respectively from Claims 30, 31 and 32 provide limitations like those of Claims 5, 6 and 10 and are patentably distinct over the cited references for the same reasons advanced for Claims 5, 6 and 10 above.

Claim 34.

This claim specifies that the inner diameter of the tool joint varies as a function of tool joint length. None of the cited references show anything like this. Claim 34 defines patentably over the cited reference.

Claim 35

This claim specifies that the double shoulder connection is characterized by a pin nose cross section area, CS_{PN} which is at least 50% larger than the smaller of the area of the cross section of box counterbore CS_{BC} or the cross section of the pin base CS_{PB} and that the pin nose length L_{PN} is from about 1 to 1.5 times the counterbore length L_{BC}.

Please see the remarks regarding Claim 13 above relevant to the relative lengths of L_{PN} and L_{BC}.

Also please refer to the specification of this application at page 13 line 20 to page 14 line 4:

> ". . . the pin nose cross sectional area CS_{PN} is at least fifty percent as large as the smaller of the cross sectional area of the box counterbore CS_{BC} or cross sectional area of the pin bore CS_{PB}. Such a relationship in pin nose, pin base, and counterbore cross section areas results in least fifty percent increase in torsional strength of the connection 4 as compared to a conventional API connection of comparable size."

Also please refer to the "Drawings" portion of this response which indicates that the relationship among CS_{PN}, CS_{BC} and CS_{PB} as specified both in the written specification and Claim 35 is illustrated in Figure 2.

None of the references disclose or suggest the two structural features of the characterizing clause of Claim 35:

$CS_{PN} \geq 50\%$ (smaller of CS_{BC} or CS_{PB}) and

$L_{PN} \geq (1.0 \text{ to } 1.5)\ L_{BC}$.

Accordingly, Claim 35 defines a novel, unobvious invention over the references cited in the Office Action. In view of these remarks, kindly reconsider the §103 rejection of Claim 35 in the March 17, 2006 Office Action and allow Claim 35.

Claim 36

Claim 36 has been amended to change the dimension of length L_{BC} from "34" to --1" --. Such amendment is supported at page 9 lines 9 and 10 of the specification. No new matter has been added.

Claim 36, by its dependence on Claim 35 and the specific structural feature of L_{BC} = 1", defines patentably over the cited prior art.

Claim 37

Claim 37 is patentable by its dependence on Claim 36 and further by its limitation as to structural dimensions regarding thread arrangement characteristics of pitch, thread major diameter and pitch diameter to produce a connection which requires less than 8 turns from stabbed to snugged. Please refer to applicants' remarks above regarding Claims 2, 3 which indicate that the art of record does not disclose or suggest a double shoulder connection as specified by Claims 35, 36 which is arranged to produce an 8 turn stabbed to snugged characteristic. Accordingly, Claim 37 also defines patentably over the references.

Corresponding PCT Application

The examiner is invited to review the written opinion of the Canadian Patent Office concerning substantially identical claims which are in an international patent application. Such opinion and references are included in the Information Disclosure Statement submitted herewith.

CONCLUSION

All the Claims, 1-37 some of which have been amended for clarity, are patentably distinct over the art of record. Kindly allow all the claims and pass the application to issue.

Respectfully submitted,

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Enclosures:

1) Petition for 2 months extension of time
2) Information Disclosure Statement